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The Economics of Interconnection

by

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Preface

The three papers by Gerald W. Brock compiled herein are a clear, concise analysis of the economics of interconnection. Mr. Brock, former Chief, Common Carrier Bureau, U.S. Federal Communications Commission and now professor of telecommunication and Director, Graduate Telecommunication Program, the George Washington University, Washington, DC, goes to the heart of local telecommunications competition: compensation for the exchange of traffic among interconnected local networks, some of which retain market power. Mr. Brock explains how compensation arrangements that are administratively simple, economically correct and consistent with maximum network efficiency would arise in fully competitive markets. He explains why a market in transition to competition needs regulatory controls on compensation for interconnection, and why such regulatory controls must limit compensation to the actual cost of service. He explains why zero-priced interconnection ("sender keep all"), such as has been agreed to by commercial service providers on the Internet, meets these economic requirements. And he shows that "sender keep all" is a logical compensation arrangement in light of the fact that the incremental cost of providing necessary capacity for terminating traffic-- the only theoretically correct basis for calculating a call completion charge -- is trivial.

The Economics of Interconnection

by Gerald Brock

Introduction

The issues of interconnection rights and the compensation to be paid for traffic exchanged among interconnected companies have played a crucial role in the development of competitive alternatives throughout the history of the telecommunication industry. Interconnection disputes began with the early efforts to expand market power in the mid-nineteenth century telegraph industry and have continued to the present.[1] Although the long history of interconnection controversies provides several models of possible solutions to interconnection issues, the problems have not all been solved.

The emerging local competition requires an interconnection policy that will allow the efficient development of a "network of networks" in which customers have access to any combination of private and multiple public communications networks. The interconnection rules to and from monopoly networks should not be dependent on technology and should apply to both wireline and wireless services. This problem is more complex than past ones because there are no clear stationary boundaries across which interconnection must occur and because there will be a need for interconnection among companies with different and changing degrees of market power.

One important goal of regulation is to bring the results of a monopolized or partially monopolized market closer to what would occur under competitive conditions. Thus in considering the desirable price structure for regulated interconnection, the expected price structure under full competition is a useful guide.

The best existing example of interconnection under competitive conditions without regulation is the interconnection of commercial providers of Internet services. Because the Internet consists of many interconnected networks with relatively easy entry conditions and no regulation, it provides an example of a competitive network of networks. The growth of commercial services on the Internet and limitations on commercial products on the backbone network controlled by the National Science

[1]A brief summary of FCC efforts to devise appropriate interconnection policies for customer premises equipment, long distance service, and international service is contained in the appendix to this paper. For a more complete account see generally Gerald Brock, The Telecommunications Industry: The Dynamics of Market Structure (Harvard University Press, 1981) and Telecommunication Policy for the Information Age: From Monopoly to Competition (Harvard University Press, 1994).

Foundation led to the formation of the Commercial Internet Exchange (CIX) in August 1991. Commercial Internet service providers agreed that interchange of traffic among them was of mutual benefit and that each should accept traffic from the other without settlements payments or interconnection charges. The CIX members therefore agreed to exchange traffic on a "sender keep all" basis in which each provider charges its own customers for originating traffic and agrees to terminate traffic for other providers without charge.[2]

The Internet example suggests that "sender keep all" interconnection arrangements are likely to develop in competitive communications markets as the compensation method for mutually beneficial interconnection arrangements. However, most telecommunication markets are not fully competitive. Incumbent telephone companies with market power have an incentive to use interconnection prices as a method of limiting competitive entry.

In November 1994, the European Commission released a study that it commissioned from a prestigious group of European and American telecommunication experts regarding issues of interconnection in an increasingly competitive telecommunication industry.[3] The study found that continued regulatory oversight of interconnection conditions would be necessary in order to allow effective competition to flourish. It recommended that interconnection rates be based on cost and set as a capacity charge. The European Commission study's conclusions that telephone company incumbents will set interconnection prices too high without regulatory controls and that interconnection charges should be based on the incremental cost of capacity required by the interconnector are directly relevant to the development of competition in the United States. The principles developed in that study are designed to promote a dynamic and efficient telecommunication market and are applicable to the U.S. telecommunication market as well as the European telecommunication market.

In order to apply the principle of setting interconnection charges at the incremental cost of capacity required to terminate the traffic, it is necessary to estimate that cost. The most comprehensive public engineering study of incremental cost was done by the Incremental Cost Task Force with members from GTE, Pacific Bell, the California Public Utilities Commission, and the RAND Corporation.[4] The Task Force had access to data for telephone companies in California and performed a detailed

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[2]Padmanabhan Srinagesh, "Internet Cost Structures and Interconnection Agreements," in Gerald Brock, ed. Toward a Competitive Telecommunication Industry: Selected Papers from the 1994 Telecommunications Policy Research Conference (Hillsdale, N.J.: Lawrence Erlbaum, in press).

[3]J. Arnbak, B. Mitchell, W. Neu, K. Neumann, and I. Vogelsang, Network Interconnection in the Domain of ONP: Study for DG XIII of the European Commission (Brussels: European Commission, 1994).

[4]Bridger M. Mitchell, Incremental Costs of Telephone Access and Local Use, (Santa Monica, CA: The Rand Corporation, 1990); reprinted in William Pollard, ed., Marginal Cost Techniques for Telephone Services: Symposium Proceedings (Columbus, Ohio: National Regulatory Research Institute, 1991) (NRRI 91-6).

engineering cost study for various output measures of local telephone service. Individual components were priced based on 1988 prices and costs were computed for switch investment, switch maintenance, interoffice transport, and call attempts. All costs were computed for calls during the busiest hour of the year because the investment and associated expenses are related entirely to capacity cost.

The task force computed a cost of $6.00 to $11.00 per year to provide the capacity for 100 call seconds of local usage during the busiest hour of the year, plus a cost of $.30 to $.90 per year to provide the capacity for an additional call attempt during the busiest hour of the year. Using reasonable assumptions regarding the distribution of traffic, those capacity costs translate into an average cost of supplying additional local usage capacity of approximately 0.2 cents per minute. Because the actual cost is higher than the average during the peak periods and because the actual cost is zero during non-peak periods, it is more efficient to charge based on the maximum capacity required than to charge at the average cost per minute for each minute of use.

The three attached papers discuss the interconnection issues in detail. The first focuses on the importance of using capacity measures for interconnection rather than charges per minute of use. The second reviews previous studies of the incremental cost of local usage. The third examines the implications of various interconnection policies and shows that mutual compensation without control of the actual rates for interconnection does not limit monopoly power.

The analysis in the three papers leads to the following conclusions:

(1) If there are no regulatory controls on compensation for interconnection, the monopolist of part of the market can extend its monopoly power to the entire market;

(2) A compensation policy for the mutual exchange of local traffic without limits on the level of rates does not limit market power;

(3) The interconnection of two communications networks provides a benefit to customers of both networks;

(4) The commercial providers of competitive non-regulated Internet service have recognized the mutual benefits of interconnection by agreeing to interconnect on a "sender keep all" basis, terminating traffic originated by others in exchange for having their originating traffic terminated by others;

(5) Minutes of use interconnection charges would not be sustainable in a highly competitive market;

(6) Minutes of use interconnection charges fail to attain maximum efficiency and lead to incorrect investment signals;

(7) Minutes of use interconnection charges have been used in the past as a convenient allocator for fully distributed cost under regulated monopoly, but are not appropriate in the emerging market structure of greater local competition;

(8) In order to facilitate the transition to a competitive local communications market, regulators should emulate the competitive market outcome by setting interconnection prices determined by the cost of providing the necessary capacity for terminating traffic;

(9) A reasonable estimate of the average incremental cost of terminating traffic received from a competitor using digital technology is 0.2 cents per minute, but the actual cost is determined only by the maximum capacity required and not by the total number of minutes terminated;

(10) "Sender keep all" is an administratively simple mutual compensation scheme with zero prices for terminating service. It is an attractive approximation to the theoretically correct policy of cost based prices when the incremental cost of terminating service is low.

Price Structure Issues in Interconnection Fees

Gerald W. Brock
March 30, 1995
(Prepared for Teleport Communications Group)

Summary

The interconnection of two communication networks provides a benefit to the customers of both networks by allowing customers of one network to communicate with customers of the other network. If traffic is roughly equal in both directions between the two networks, there is no need for either network to pay the other for interconnection. Each network can bill its own customers for their communications, and can terminate traffic received from the other network in exchange for the privilege of having its originating traffic terminated on the other network, an arrangement known as "sender keep all".

If traffic is primarily one way, it may be necessary for the company that is terminating the traffic to impose interconnection charges as compensation for the service it provides to the other company. If interconnection charges are imposed, they should be assessed at the long run incremental cost of adding capacity. The price structure should be a capacity charge per unit of time (as in private lines), not a minutes of use charge. A minutes of use charge causes inefficient calling choices and investment decisions and it would not occur in a competitive market.

I. Introduction

One important goal of regulation is to bring the results of a monopolized or partially monopolized market closer to what would occur under competitive conditions. Thus in considering the desirable price structure for regulated interconnection, the expected price structure under full competition is a useful guide.

The best existing example of interconnection under competitive conditions without regulation is the interconnection of commercial providers of Internet services. Because the Internet consists of many interconnected networks with relatively easy entry conditions and no regulation, it provides an example of a competitive network of networks. The growth of commercial services on the Internet and limitations on commercial products on the backbone network controlled by the National Science Foundation led to the formation of the Commercial Internet Exchange (CIX) in August 1991. Commercial Internet service providers agreed that interchange of traffic among them was of mutual benefit and that each should accept traffic from the other without settlements payments or interconnection charges. The CIX members therefore agreed to exchange traffic on a "sender keep all" basis in which each provider charges its own customers for originating traffic and agrees to terminate traffic for other providers without charge.[1]

The Internet example suggests that "sender keep all" interconnection arrangements are likely to develop in competitive communications markets as the compensation method for mutually beneficial interconnection arrangements. However, most telecommunication markets are not fully competitive. Incumbent telephone companies with market power have an incentive to use interconnection prices as a method of limiting competitive entry. Interconnection arrangements and prices have consequently been a major regulatory issue in the United States and other countries that have allowed competition in communications markets. Interconnection arrangements continue to be a critical factor in the viability of communications competition.

In November 1994, the European Commission released a study that it commissioned from a prestigious group of European and American telecommunication experts regarding issues of interconnection in an increasingly competitive telecommunication industry.[2] The study found that continued regulatory oversight of interconnection conditions would be necessary in order to allow effective competition to flourish. It recommended that interconnection rates be based on cost and set as a capacity charge. Specifically, the study concluded:

1. "If left to themselves, markets for interconnection services are likely to reflect either collusive arrangements or monopoly power of incumbent TOs [Telecommunication Operators]. In either case, interconnection prices are likely to be too high relative to prices that would emerge under competitive conditions."[3]

2. "We call for cost-based interconnection charges (based on MC_{IX} or AIC_{IX}) [marginal cost of interconnection or average incremental cost of interconnection].[4]

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[1] Padmanabhan Srinagesh, "Internet Cost Structures and Interconnection Agreements," in Gerald Brock, ed. Toward a Competitive Telecommunication Industry: Selected Papers from the 1994 Telecommunications Policy Research Conference (Hillsdale, N.J.: Lawrence Erlbaum, in press).

[2] J. Arnbak, B. Mitchell, W. Neu, K. Neumann, and I. Vogelsang, Network Interconnection in the Domain of ONP: Study for DG XII of the European Commission (Brussels: European Commission, 1994).

[3] Ibid., p. 69.

[4] Ibid., p. 84.

3. "The main costs associated with interconnection are for long-lived capacity. They therefore represent capital costs that are the sum of financing costs and loss in value of the capital goods over time. ...We consider capacity-based interconnection charges to be the optimal approach for interconnection between a sophisticated TO [Telecommunication Operator] and a sophisticated interconnector."[5]

The European Commission study's conclusions that telephone company incumbents will set interconnection prices too high without regulatory controls and that interconnection charges should be based on the incremental cost of capacity required by the interconnector are directly relevant to the development of competition in the United States. The principles developed in that study are designed to promote a dynamic and efficient telecommunication market and are applicable to the U.S. telecommunication market as well as the European telecommunication market.

This paper focuses on the importance of using capacity measures for interconnection rather than charges per minute of use. Specific conclusions with regard to the price structure for interconnection charges include:

(1) Minutes of use interconnection charges would not be sustainable in a highly competitive market;

(2) Minutes of use interconnection charges fail to attain efficiency and lead to incorrect investment signals;

(3) Minutes of use interconnection charges have been used in the past as a convenient allocator for fully distributed cost under regulated monopoly, but are not appropriate for the emerging market structure of greater competition.

II. Competition and Interconnection Charges

We should expect to see "sender keep all" arrangements develop in a competitive communications market if either of two conditions are met:

(1) Traffic flows are very roughly balanced among the companies so that each sees a clear benefit for its customers in both sending and receiving traffic from other companies; OR

[5] Ibid., p. 92, 94.

(2) The cost to a company of terminating traffic is low in relationship to the transactions costs of measuring and charging for traffic so that even with unbalanced traffic companies find the simple "sender keep all" approach superior to efforts to develop appropriate cost-based terminating charges.

In a competitive communications market, we should only expect to see interconnection charges when traffic is largely one way so that the receiving company is disadvantaged by "sender keep all" and when the costs of terminating traffic are substantial in relationship to the transactions cost of developing and collecting interconnection charges. Under those conditions, we should expect to see interconnection charges based on the cost of the capacity required to terminate traffic.

The most comprehensive public engineering study of the incremental cost of local telephone usage (and therefore of the cost of terminating telephone traffic for competitors) was done by the Incremental Cost Task Force with members from GTE, Pacific Bell, the California Public Utilities Commission, and the RAND Corporation.[6] The Task Force had access to data for telephone companies in California and performed a detailed engineering cost study for various output measures of local telephone service. Individual components were priced based on 1988 prices and costs were computed for switch investment, switch maintenance, interoffice transport, and call attempt costs. All costs were computed for calls during the busiest hour of the year because the investment and associated expenses are related entirely to capacity cost. The Task Force computed the following usage costs for each hundred call seconds (CCS) during the busiest hour of the year for "average" and "larger urban" exchanges:

switch investment	\$5.00	- \$ 10.00 per year
switch maintenance	.20	- .50 per year
interoffice calling	.50	- .60 per year
Total	\$6.00	- \$11.00 per year

In addition, the task force computed a cost of \$.30 to \$.90 per year for each call attempt during the busiest hour of the year and estimated approximately 1.25 busy hour attempts per busy hour CCS.[7]

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[6]Bridger M. Mitchell, <u>Incremental Costs of Telephone Access and Local Use</u>, (Santa Monica, CA: The Rand Corporation, 1990); reprinted in William Pollard, ed., <u>Marginal Cost Techniques for Telephone Services: Symposium Proceedings</u> Columbus, Ohio: National Regulatory Research Institute,1991) (NRRI 91-6).

[7]Ibid., p. 249, 250.

The task force found that all costs were related to the capacity of the facilities used and could best be expressed as costs per year for capacity, rather than as costs per minute or per call. Using reasonable assumptions regarding the distribution of traffic, the costs determined by the Incremental Cost Task Force translate into an average of approximately 0.2 cents per minute, but most of the minutes during a year impose no incremental cost on the local exchange because they occur at off peak times.

A simple but useful way of analyzing the competitive interconnection issues is to consider two separate communities, A and B.[8] Each is served by a single telephone company, but entry and exit are easy ("contestable markets" in economic terms). The cost for each company of terminating traffic for the other is the cost of building a channel of adequate capacity for the peak terminating load between the two companys' switches. The size of the channel is a proxy for all of the capacity related costs in terminating traffic. As discussed above, if the traffic is reasonably balanced or if the costs of providing terminating service are low in relationship to transactions costs, it is likely that both companies will find it in their mutual interest to provide terminating service for the other and will provide it on a "sender keep all" basis without explicit terminating charges.

Consider the case in which terminating cost (the cost of the channel between A and B) is substantial and the terminating traffic is all one way from A to B. That is, customers of A wish to terminate traffic in B, but customers of B have no desire to terminate traffic in A. In that case, A will have to pay the cost of termination because B is not getting a reciprocal benefit. There are two ways to manage the termination:

(1) A could build the channel to B if that were technically feasible.[9] Then the cost of termination for A would be the capacity cost for the peak termination load.

(2) B could build the channel to A (add necessary capacity to its local facilities) and charge A for using it.

If B offers a long term contract based on the cost of providing a given capacity, then the price structure will be similar to the cost structure that A would incur by building the capacity itself. Either ownership method would create an effective rental

[8]They are not necessarily physically distinct communities but are communities connected to particular communication networks.

[9]A simple channel would obviously be technically feasible, but the more realistic case in which terminating traffic requires an increase in capacity of B's switches, interoffice transport, and so forth might not be technically feasible.

price per time unit based on the capacity of the channel without regard to the actual number of minutes passing through it. However, suppose that B builds the necessary capacity to A and then decides to cover the cost with a charge per minute. Assume that the price per minute is determined by dividing the annual cost of the channel by the forecast number of minutes, so that B just covers its total cost. The price per minute will be higher than the true cost for off-peak usage and lower than the true cost for on-peak usage. That price structure would not be sustainable in a contestable market because a new entrant that offered prices more closely aligned with cost would attract all of the off-peak traffic. As the incumbent loses the off-peak traffic, its average price will no longer cover its cost and it will be forced to raise prices for the remaining traffic. The only sustainable price structure will be a cost-based charge related to the capacity of the facilities used to provide terminating service.

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The reason why only capacity based charges would be sustainable in a competitive market can be clarified by considering the competitive market for rental automobiles. The cost of providing rental automobiles is more closely related to the time the car is rented than to the number of miles driven. Consequently, most rental companies charge by the time rented (day, week, or month) rather than by the number of miles driven. Charging by time for rental automobiles corresponds to capacity charges for interconnection while charging by miles driven corresponds to charges per minute of use for interconnection.

Suppose one rental company decided that all drivers should pay for each mile driven and set its rates as a price per mile rather than a price per day. Before customers adjusted to the changed price structure, the company could receive the same revenue with either method by simply setting the price per mile equal to the previous price per day divided by the average number of miles per day. However, that price structure could not last in a competitive market. It would cause those who drive long distances per day to pay far more than those who drive short distances. Because the real costs are related to the time the car is rented rather than to the number of miles, another company would offer a flat rate with unlimited miles and attract all of the long distance drivers. The company charging per mile rates would be left with only those who drive very short distances and would no longer cover its cost with the initial rates. As it raised its rates per mile in order to covers its cost, it would lose additional customers and eventually it would be forced to impose a cost related time charge in order to stay in the competitive business. Similarly, a competitive communications company would be forced to impose a cost related capacity charge rather than a minutes of use charge in order to survive in a competitive communications market.

III. Monopoly and Interconnection Charges

If the company providing interconnection services has a monopoly, then interconnection charges per minute of use will be sustainable because there is no competitive pressure to price in accordance with cost. However, interconnection prices based on minutes of use will not lead to maximum efficiency. They will distort both consumer decisions and investment decisions because they provide the wrong price signals.

Minutes of use pricing has been used extensively in the monopoly telecommunication industry of the past. Pricing on a minutes of use basis was mandated in the federal access charge plan. The access charge plan created in preparation for the January 1, 1984 divestiture of AT&T created a rigid structure of the prices to be paid from interexchange carriers to local exchange carriers for originating and terminating interstate traffic. Particular categories of cost determined by prescribed cost allocation procedures were required to be recovered by dividing the cost category by the forecast number of minutes and charging interexchange carriers the resulting price per minute for the access element.[10]

Although the per minute access charges were sustainable because of the largely monopoly structure of the local exchange industry, they distorted both consumer and business decisions away from maximum efficiency. On the consumer side, the access charges made it expensive for long distance companies to serve off peak residential customers. Long distance companies paid the same rate per minute to local telephone companies for traffic terminated late at night as they paid for traffic terminated at the peak of the business day. Consequently, discounted consumer rate plans for night calls that were established prior to the implementation of access charges became unprofitable. Long distance companies were forced to raise their prices to night time residential callers because of the artificial access charge structure even though the night time calls (utilizing otherwise idle capacity) imposed practically no cost on either long distance or local exchange companies.

Prior to the implementation of the federal access charge plan, an interim plan for initial long distance competition imposed access charges on long distance providers based on capacity used. That plan provided incentives for carriers such as MCI and Sprint to aggressively develop their residential customer base because residential calls were

[10] The legal description of the access charge plan is found in Title 47 of the Code of Federal Regulations, Parts 36 (separations cost allocations) and 69 (computation of access charges). An account of the political and economic issues related to access charges is contained in Gerald Brock, Telecommunication Policy for the Information Age: From Monopoly to Competition (Cambridge, MA: Harvard University Press, 1994),chapters 10 and 11.

primarily off peak and imposed little or no cost on the companies. Once the access charge plan was implemented with its per minute charges for all traffic regardless of when it occurred, the companies found that business traffic was more profitable than residential traffic. The incentives created by the minutes of use access charges thus distorted business marketing and investment decisions away from the efficient path.

The pernicious efficiency and investment effects of minutes of use interconnection charges can be illustrated by considering a regulated monopoly automobile rental company. If it (or its regulator) decides that charges should be determined by the mileage driven rather than by the time the automobile is rented, the resulting rate structure will be sustainable and can be designed to allow the company to recover its total revenue requirement. However, consumers will have an incentive to rent many cars for occasional short mileage driving. If the company is required to provide rental cars at the established rate to all who request them, it will be forced to make large investments in underutilized capital. It will recoup the costs of the investment by imposing very high charges on the long distance drivers.

The monopoly rental company will report to its regulators that it is subsidizing short distance drivers who are being provided cars below cost. Both the company and its regulators will be concerned about any proposals for competition because competitors would "cream-skim" the profitable long distance drivers, leaving only the unprofitable short distance drivers to the regulated company and threatening its viability. However, the entire problem is simply that the price structure does not correspond to the cost structure. The distortions and regulatory problems could be solved by shifting to a time based rental structure that matched the structure of cost in that market. Similarly, minutes of use access or interconnection charges reduce efficiency, create wrong investment incentives, and increase the difficulty of moving toward a competitive communications industry.

IV. Conclusion

Several conclusions can be drawn from this analysis:

(1) The interconnection of two communications networks provides a benefit to customers of both networks;

(2) The commercial providers of competitive non-regulated Internet service have recognized the mutual benefits of interconnection by agreeing to interconnect on a "sender keep all" basis, terminating traffic originated by others in exchange for having their originating traffic terminated by others. This is a useful model for

interconnection of competing local exchange networks;

(3) Minutes of use interconnection charges would not be sustainable in a highly competitive market;

(4) Minutes of use interconnection charges fail to attain maximum efficiency and lead to incorrect investment signals;

(5) Minutes of use interconnection charges have been used in the past as a convenient allocator for fully distributed cost under regulated monopoly, but are not appropriate in the emerging market structure of greater competition;

(6) In order to facilitate the transition to a competitive communications market, regulators should emulate the competitive market outcome by setting interconnection prices (if "sender keep all" is not acceptable) determined by the cost of providing the necessary capacity for terminating traffic.

Interconnection And Mutual Compensation With Partial Competition

Gerald W. Brock
(Prepared for Comcast Corporation)

I. Introduction

This paper examines the economic characteristics of various interconnection compensation policies when there are different levels of market power among the participants. The conclusions of the analysis are:

(1) If there are no regulatory controls on compensation for interconnection, the monopolist of part of the market can extend its monopoly power to the entire market;
(2) A mutual compensation policy without limits on the level of rates does not limit market power;
(3) The level of rates under a mutual compensation policy is unimportant if and only if the level of incoming and outgoing traffic is exactly balanced. Because traffic levels will rarely, if ever, be exactly balanced, the level of rates will be an important factor in the viability of competition;
(4) A mutual compensation policy with prices limited to the cost of service is the theoretically correct compensation policy. Mutual compensation with prices limited to the cost of service prevents the monopolist of part of the market from extending its market power to potentially competitive sectors of the market;
(5) Capacity charges rather than per minute charges allow attention to be focused on the cost of service at the peak load which is generally the real cost of service;
(6) "Sender keep all" is an administratively simple mutual compensation scheme with zero prices for terminating service. It is an attractive approximation to the theoretically correct policy of cost based prices when the incremental cost of terminating service is low.

The issues of interconnection rights and the compensation to be paid for traffic exchanged among interconnected companies have played a crucial role in the development of competitive alternatives throughout the history of the telecommunication industry. Interconnection disputes began with the early efforts to expand market power in the mid-nineteenth century telegraph industry and have continued to the present.[1]

[1]A brief summary of FCC efforts to devise appropriate interconnection policies for customer premises equipment, long distance service, and international service is contained in the appendix to this paper. For a more complete account see generally Gerald Brock, The Telecommunications Industry: The Dynamics of Market

Although the long history of interconnection controversies provides several models of possible solutions to interconnection issues, the problems have not all been solved. Past interconnection controversies have led to three different kinds of solutions:

(1) The customer premises equipment (CPE) model of zero interconnection charges;
(2) The long distance model of substantial one-way per minute interconnection charges;
(3) The international model of two-way per minute interconnection charges.

The emerging local competition requires an interconnection policy that will allow the efficient development of a "network of networks" in which customers have access to any combination of private and multiple public communications networks. The interconnection rules to and from monopoly networks should not be dependent on technology and should apply to both wireline and wireless services. This problem is more complex than past ones because there are no clear stationary boundaries across which interconnection must occur and because there will be a need for interconnection among companies with different and changing degrees of market power.

Both the CPE interconnection rules and the long distance provider access charge rules were developed in a context in which competitors were seeking interconnection with a monopoly public network. The international model provides a closer analogy to the emerging competition in which there may not be a clearly defined monopoly public network. Traditionally, international service has been provided jointly by the national carriers with neither national carrier allowed to provide service directly into the other carrier's country. The international accounting rate and settlement rate system is a mutual compensation arrangement in which the level of payment is negotiated by the carrier pairs and that level of payment is generally used for traffic in either direction. Whatever level of payment is chosen for carrier A to compensate carrier B for terminating traffic received from A is generally the same level used for carrier B to compensate carrier A for terminating traffic received from B.

The mutual benefit and mutual compensation aspects of the international model make it appealing as a framework for interconnection of a wide variety of networks in the future. However, even the increasingly competitive future situation is likely to retain areas of monopoly power, and the international model has encountered difficulties in dealing with different levels of market power among the participants in the bargain.

Structure (Harvard University Press, 1981) and Telecommunication Policy for the Information Age: From Monopoly to Competition (Harvard University Press, 1994).

With the mutual compensation approach, the actual level of payments makes no difference so long as traffic is exactly balanced in both directions. For example, suppose carriers A and B each originate 100 minutes of traffic to be terminated by the other. If the compensation rate for termination is $1, each pays the other $100, while if the compensation rate is $10, each pays the other $1000. In either case the payments exactly cancel out.

If traffic is unbalanced, the compensation rate does matter. If the more competitive carrier originates more traffic than it terminates (as has been the typical pattern in international communications), then a high mutual compensation rate favors the monopolist. For example, suppose low prices in competitive market B cause companies to originate 100 minutes while high prices in monopolized market A cause companies to only originate 50 minutes. Then a compensation rate for termination of $1 causes a net payment from B to A of $50, while a compensation rate of $10 causes a net payment from B to A of $500. Evan Kwerel's analysis of the international market concluded that with a net traffic outflow toward the monopolist, the mutual compensation principle does not limit the monopolist's ability to extract profit from the more competitive partner: "When the net traffic flow is out of the U.S., as with international MTS, ... U.S. carriers are making net payments to the PTT. The PTT can extract the same total revenue from U.S. carriers regardless of the terms for dividing the accounting rate by demanding a sufficiently high accounting rate."[2]

Because lower prices for calls originating in the competitive U.S. market than for calls originating in the generally monopolized foreign markets have created a net traffic outflow from the U.S., compensation rates above cost have created an increasingly large balance of payments deficit. Net outflow from U.S. carriers to foreign carriers increased by a factor of 10 between 1980 and 1992, rising from $347 million in 1980 to $3,344 million in 1992.[3] The rising balance of payments deficit due to compensation rates above cost has led to extensive consideration at the FCC and other U.S. government agencies of ways to attain the "objective of promoting lower, more economically efficient, cost-based international accounting rates and calling prices."[4]

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[2]Evan Kwerel, "Promoting Competition Piecemeal in International Telecommunications," FCC, OPP Working Paper 13 (December 1984), p. 49.

[3]FCC, Industry Analysis Division, "Trends in Telephone Service," (May 1994), Table 31, p. 48.

[4]"In the Matter of Regulation of International Accounting Rates," CC Docket 90-337, 6 FCC Rcd. 3552 (1991) at 3552.

II. A Framework for Analyzing Interconnection Issues

Today's communications marketplace is a hybrid with market segments of robust competition (no barriers to entry) and market segments of little or no competition (extensive barriers to entry). The problem is to create an interconnection policy that will be feasible across a wide range of situations, including different cost situations, different technologies such as wired and wireless, and different degrees of market power. The interconnection arrangements should be flexible enough to meet changing circumstances rather than having the rigidity of the existing prescribed access charge structure.

The interconnection and compensation arrangements are critical for the development of competitive benefits when there are some market segments with market power and other market segments subject to potential competition. Assume that customers can be divided into two groups: a set A for which entry is very difficult and a set B for which entry is easy. The division of the customers into two classes creates four different types of traffic:

(1) traffic among the customers in A, designated AA traffic.
(2) traffic originating from a customer in A and terminating in a customer of B, designated AB traffic.
(3) traffic originating from a customer in B and terminating in a customer of A, designated BA traffic.
(4) traffic among the customers in set B, designated BB traffic.

The significance of interconnection policy depends upon the relative sizes of AB and BA traffic compared to AA and BB traffic. If, for example, A and B represent very different kinds of customers with no desire to communicate between the groups, then AB and BA would be very small and interconnection policy would be largely irrelevant. In that specialized case, there could be one system serving A customers and a completely separate system serving B customers with no loss in efficiency. However, in the more normal case, the division of customers between A and B is a function of geography and customer characteristics that do not affect their desire to communicate with each other. Thus AB and BA represent substantial streams of traffic and it is necessary to have interconnection among the systems in order to promote efficiency.

A second factor that affects the importance of interconnection policy is the existence of fixed costs per subscriber compared to costs per unit of traffic. If there are no fixed costs per subscriber (any number of subscribers can be served at the same total cost so long as the total traffic carried is the same), then interconnection policy is less important than when there are fixed costs per subscriber. With no fixed costs per subscriber, it may be efficient to serve the different traffic streams with different systems (one system for BB traffic and another for BA traffic, for example). With fixed costs per subscriber, the subscriber must choose the system that best fits that subscriber's needs. Limitations on AB and BA traffic may make a separate system for BB traffic infeasible with fixed costs per subscriber, but not with only usage costs.

The remainder of this paper examines some of the interconnection issues with a "toy model" consisting of a total universe of six subscribers who desire to communicate with each other. The simplified model allows explicit solutions to be worked out in a way that is more obvious than either more realistic simulation models or mathematical formulations. However, the results are quite general and not dependent upon the specific characteristics of the simple model presented.

Assume there are six individuals, designated 1 through 6. Each person i has a linear demand curve for communication with each of the other five individuals shown in Figure 1. Each person demands 3 calls per time period with each other person when the price is zero per call, 2 calls per time period when the price is $1 per call, 1 call per time period when the price is $2 per call, and at a price of $3 per call is priced out of the market. If all six people are connected in a network, the total demand of person i for communication with the other five individuals is simply the sum of i's demand for communication with each of the individuals as shown in Figure 2; person i has a demand for 10 calls per time period to the entire network at a price of $1 per call because person i desires to make two calls to each of the other five people at that price.

Assume that the cost of providing each call is $0.5 for each call originated and $0.5 for each call terminated. Thus the usage cost per call is $1 for each call carried entirely over one network and is $.5 for each call originated or terminated on the network. There are no interconnection costs for multiple networks. That is, the real interconnection cost (but not necessarily the price) of interconnection is zero, though there is a real cost to the networks of terminating traffic provided by other networks.

With a cost of $1 per complete call, the competitive price is $1 yielding a quantity demanded of 2 per person-pair or of 10 calls per person to the other people on the network. The pure monopoly price is $2 per complete call yielding a quantity demanded of 1 per person-pair or 5 calls per person to the other people on the network, as illustrated in Figures 1 and 2.[5] The monopoly price of $2 per call yields a monopoly profit of $1 per person-pair, while the competitive price of $1 per call is equal to the

[5]The person-pair inverse demand curve is $P = 3 - Q_{ij}$ where P is the price per call and Q_{ij} is the number of calls from person i to person j. The corresponding marginal revenue curve is $MR = 3 - 2Q_{ij}$. Using the monopoly profit maximizing condition of marginal revenue equals marginal cost when marginal cost equals 1 yields a quantity of 1 and corresponding price of 2 for each person pair.

FIGURE 1

One Person's Demand Curve for calls to one other person

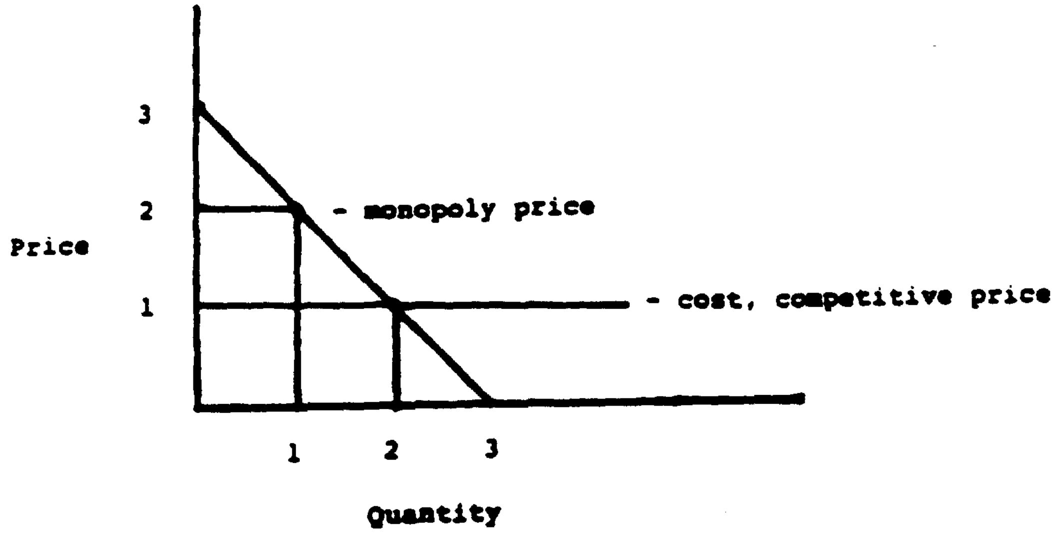
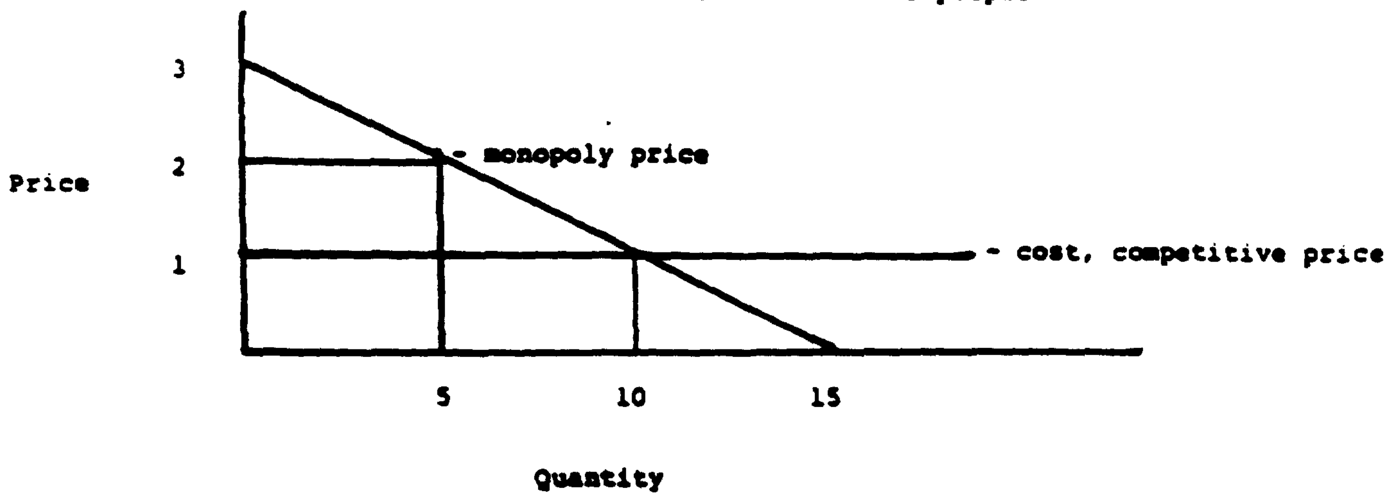


FIGURE 2

One Person's Demand Curve for calls to all five other people



costs and yields no net economic profit. With no fixed costs per subscriber, the potential monopoly profit from the network is $30 (6 subscribers each making one call per time period to 5 other subscribers and generating a monopoly profit of $1 per call).

Assume that the incumbent is the only possible provider of service to the first three subscribers while anyone can serve the remaining three subscribers. That is, subscribers 1, 2, and 3 are in the set A of monopolized subscribers while subscribers 4, 5, and 6 are in the set B of competitive subscribers. There is no regulation of the prices that the monopolist can charge its own customers. In a standard market with no network externalities, these conditions would allow the monopolist of the A customers to extract monopoly profits from them, but would not allow the monopolist to extend its monopoly power to the B customers. The network nature of telephone service makes it possible for the monopolist to extend its power to the B customers through control of interconnection conditions. The best that an interconnection policy can do is to restrict the monopoly power to the set A. That is, a good interconnection policy will reduce potential monopoly profits from $30 (the level at which all customers pay monopoly prices) to $15 (the level at which A customers pay monopoly prices and B customers pay competitive prices). No interconnection policy in itself can reduce the monopoly power over A customers, but a poorly functioning interconnection policy can allow the monopoly to be extended to part or all of the calls from the potentially competitive B customers as well. The monopoly extension occurs because a poorly functioning interconnection policy limits the ability of carriers in B to terminate calls on A's monopoly network and may make competition in B infeasible.

The following examples assume for simplicity that only linear pricing (a specified charge per call) may be used, though the price may be different for different classes of customers. Allowing more complex pricing plans (such as multiple combinations of fixed and usage charges) would produce different numbers but would not yield different conclusions.

III. No Fixed Costs per Subscriber

With no fixed costs per subscriber, the monopolist of A sets a price of $2 for AA calls (originating and terminating among customers of A), while the competitors that serve B set a price of $1 (equal to cost) for BB calls. The interconnection conditions determine the prices for AB and BA calls.

A. No Required Interconnection

If there is no interconnection requirement, A can monopolize the AB and the BA calls along with the AA calls, but cannot monopolize the BB calls in the absence of fixed costs. The monopolist of A can guarantee itself access to the customers of B either by purchasing access from a current supplier or by establishing its own affiliate to serve B. Competition in B means that no one can charge more than $.50 (the cost of termination) for terminating calls from A; otherwise, another competitor would offer to do it more cheaply. A will maximize profits from its monopoly by charging a price of $2.00 for AB calls (yielding a net profit of $1 per call after paying its own expenses of $.50 for originating and the competitive termination fee of $.50), and charging an access fee of $1.50 for BA calls. Because B is competitive and the cost of originating calls is $.50, the B competitors will charge $2.00 for BA calls, just equal to their total cost of $.50 for origination and $1.50 for termination.

Under these conditions, the equilibrium is full monopoly pricing of $2.00 per call for AA, AB, and BA calls (each yielding a net profit above cost of $1.00 per call) and competitive pricing of $1.00 per call for BB calls (equal to the cost of service and thus yielding a net profit above cost of zero). The monopolist of A will make a profit of $24 ($1 each on the 24 total calls made at a price of $2.00 for AA, AB, and BA calls). There will be 12 BB calls at a price of $1.00 each, yielding a net profit of zero. If there had been a complete monopoly of both A and B, the potential profits in this situation would have been $30 (including the $24 realized profits and the $6 unrealized profits that would have come from pricing BB calls at the monopoly level of $2.00 each). The monopolist of half of the subscribers makes 80 percent of the total possible monopoly profits because of its control of interconnection conditions. In other words, bringing competition to half of the subscribers only reduced monopoly power by 20 percent.

B. Required interconnection with mutual compensation

In this situation, companies are required to provide interconnection with each other, and are required to charge and receive the same rate. That is, whatever one company charges for terminating calls must be the same rate it pays the other company for terminating calls. As in the first case, the monopolized AA calls will be charged at the pure monopoly rate of $2.00 and the competitive BB calls charged at the cost-based rate of $1.00 each. Now, however, the situation above in which A charges $1.50 for terminating calls received from B and pays $.50 to B for B's service in terminating calls received from A is disallowed because the rates must be the same.

While this case appears to reduce A's monopoly power, it generally does not affect it at all. Only in the very specialized case of exactly balanced traffic does mutual compensation without control of rates limit A's monopoly power. More generally, A can use its control of the actual compensation rate together with traffic imbalances to maintain its monopoly power. Because anyone can enter the service of B, the monopolist of A can establish an affiliate that serves B. The monopolist of A can then set a compensation rate that allows it to maximize profits in both the A and B market segments while making it infeasible for competitors in B to serve traffic from B to A. For example, the monopolist of A could set a compensation rate of $2.00 for terminating any traffic received from A and also agree to pay $2.00 for any traffic delivered either to its own affiliate or to other competitors in B. For a carrier in B that is not affiliated with the monopolist of A, the competitive price for traffic from B to A is then $2.50 ($.50 cost of originating the traffic plus $2.00 paid to the monopolist of A for terminating the traffic). However, the affiliate of A will set a price of $2.00 for B to A traffic because that is the profit maximizing price for the total company. The difference in pricing comes because the non-affiliated company sees the $2.00 payment to the monopolist of A as a real cost that must be recovered in the price charged, whereas the affiliated company sees the $2.00 payment as an internal company transfer that does not affect the real cost of doing business. For the affiliated company, the size of the payment affects which entity reports the profits, but it does not affect the total profit of the combined enterprise.

Because the affiliated company prices B to A traffic at $2.00 while the non-affiliated companies price the same traffic at $2.50, customers will choose the affiliated company. Once the affiliated company monopolizes the B to A traffic, it will naturally receive the A to B traffic as well. The profit maximizing solution for the monopolist of A and its affiliate in B is consequently to set a high compensation rate (any rate above $1.50) and to price all traffic at the monopoly price of $2.00, even though some of the traffic will show high profits and some will show losses if the specified compensation rates are taken into account. The total profits of the monopolist of A and its affiliate remain at $24 or 80 percent of the total potential just as in the case of no required interconnection. Customers pay the same prices as in the case of no required interconnection. The requirement for mutual compensation has not reduced the monopoly power at all.

This case illustrates the problem with relying only on a structural solution such as mutual compensation without control of the actual rates paid. Consider, for example, the case of a local exchange company interconnecting with a wireless services provider. Assume that the local exchange company is the only service provider for some customers but that the wireless service can be provided on a competitive basis. If the local exchange company has a wireless affiliate, it can maximize the total profits of its enterprise by setting a high mutual compensation rate. Payments to the local exchange company from the wireless companies are an internal transfer for the affiliated company